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ABSTRACT

This report presents information on the second year of a 3-year project to develop hypertext computer study guides and to study their use by secondary students, including remedial students and those with learning disabilities. The first section provides an introduction to hypertext, what it is, how it is structured, and how it compares with traditional text. The second section explains the development of hypertext lessons using the HyperCard operating system and authoring environment for the Macintosh computer. It addresses principles and provides instructions for developing a hypertext template and hypertext document. The third section reports on two studies of hypertext materials. The first study used hypertext study guides in ninth grade social studies classes and focused on 15 regular education students, 10 students with learning disabilities, and 15 remedial students. The second study used the study guides with the lowest achieving students of the first study. Results of both studies indicated that students receiving only the computer study guide treatment performed better than students receiving only classroom lecture or receiving both lecture and computer study guide. Posttest and retention test scores were higher for regular, remedial, and learning-disabled students after having used the hypertext computer study guide. (Contains 17 references.) (DB)

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Hypertext and Hypermedia: Applications for Educational Use

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Hypertext: What Is It?

Hypertext: What Is It?

Hypertext and *hypermedia* are relatively new terms for today's computer using educators although the basic concept of non-sequential, computer-based text first was envisioned in 1945. Since this capability for microcomputers became widely available in 1987, interest in hypertext has been growing rapidly throughout the educational community. This recent interest has resulted in a rapid increase in the number of magazine and journal articles, papers and presentations at educational conferences, and hypertext educational software programs available for classroom use. Hypertext as an educational tool is very different from traditional computer assisted instructional software, offering a new format for providing instruction and information via a computer.

The first issue in discussing this subject is to clear up any confusion among three similar new terms being used in computer education: hypertext, hypermedia, and HyperCard. The first, hypertext, describes the concept of non-sequential text presentation. The term, hypermedia, correctly designates a hypertext document that includes graphics, digitized speech, music, or video segments. However, in this article the word hypertext refers to documents that are, strictly speaking, hypermedia. HyperCard, on the other hand, is a software product developed by Apple Computer for the Macintosh. It is an operating system and authoring environment specially designed for creating applications based on the hypertext concept.

Text, when presented in the traditional print on paper format, leads the reader through a predetermined, page-by-page progression from the beginning of

the document to the end. The reader is limited to information contained in the particular text being read. Additional information or clarification must be obtained from supplementary reference sources (e.g., a dictionary, thesaurus, encyclopedia). Hypertext, on the other hand, is a form of non-sequential text presentation. Text, when presented on a computer screen rather than conventional print on paper, loses its fixed nature and becomes more flexible and manipulable. This presentation system provides a reader an individualized way of accessing information, based on the person's needs or interests.

A hypertext page might be thought of as a composite of several sheets of transparent film overlaying one another, each sheet containing its own unique information. The top layer sheet in the hypertext page provides the initial text to be read and also serves as a menu for accessing information available on the underlying pages. The secondary text from the underlying pages is viewed by the reader in special text windows that appear either alongside or overlaying the original text. From a secondary text page or window the reader has the option to return to the original text screen without the window, or further pursue new information in additional windows. These enhancements are typically accessed through the use of a mouse. The mouse controls cursor movement and selection of computer functions often without the need for a keyboard.

In a hypertext document, words, letters, blocks of text, pictures, and parts of pictures contain links to more information than that which appears on the surface layer page or screen. This additional information may be presented as digitized speech, graphic representations, animated sequences, or clarifying text. By selecting specific areas of a hypertext page with the cursor, appropriately related

layers of information become accessible. Selecting a word, for example, could give a choice of the word's definition or pronunciation, or provide a picture associated with the word as shown in Figure 1. Cursor selection of the boldface words on the original text page (top left) reveals different types of hypertext enhancements in this educational hypertext lesson: (a) *you'll*, a text window depicts the structural analysis of the contraction; (b) *candy*, a graphic window reinforces sight vocabulary with a visual representation of candy; (c) *he*, a graphic overlay depicts the semantic and syntactic relationship of the pronoun to its referent word, Henry; and (d) *sometimes*, a computer generated voice say the word. Further selections on this second layer page or on any subsequent layer could take the reader to additional areas of information.

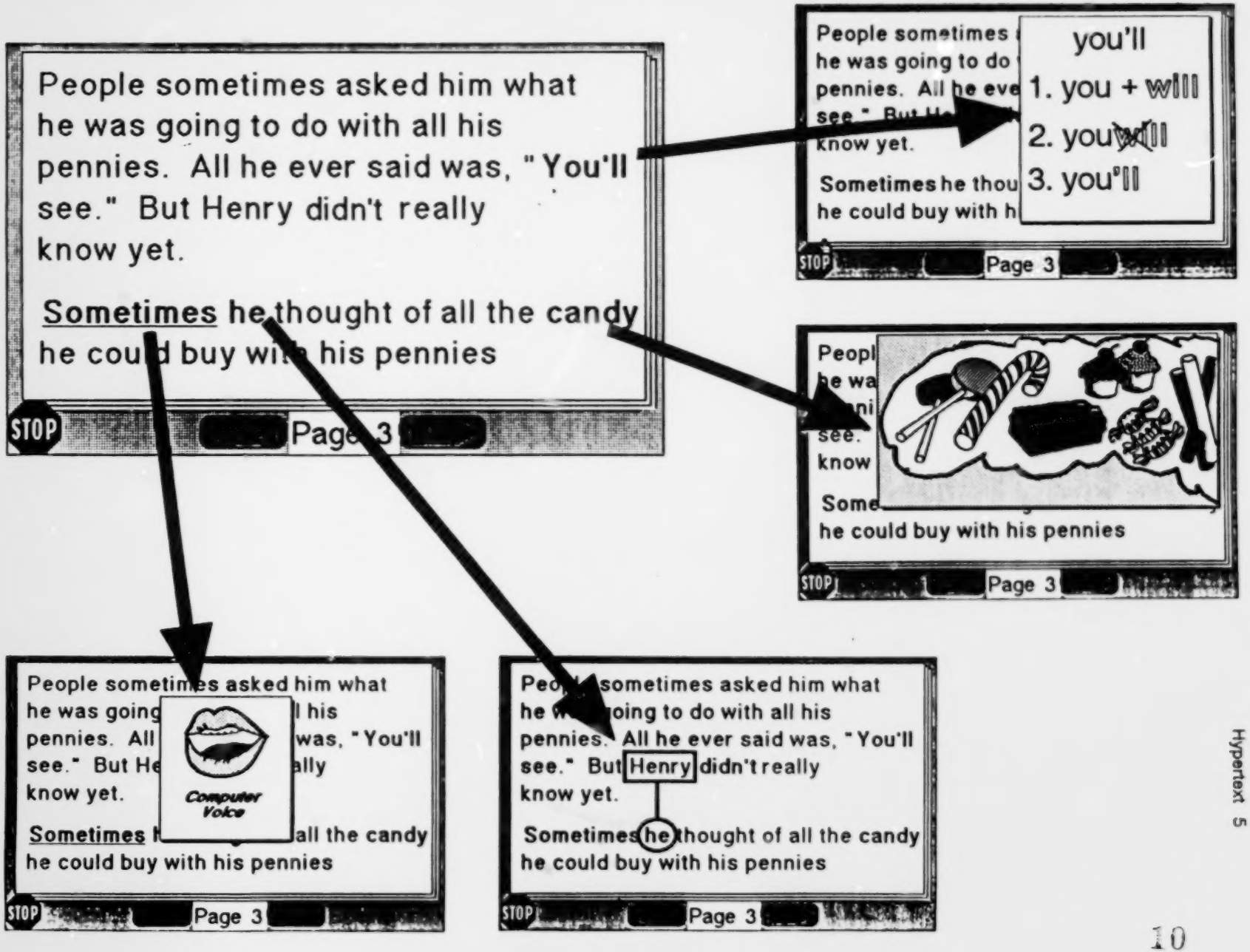
People sometimes asked him what he was going to do with all his pennies. All he ever said was, "You'll see." But Henry didn't really know yet.
Sometimes he thought of all the candy he could buy with his pennies
STOP
Page 3
you'll
1. you + will
2. you will
3. you'll
Computer Voice
Henry

Figure 1. A hypertext educational lesson flow chart.

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In addition to this expansion of information, movement through hypertext pages can be left entirely to the reader to move freely throughout the document, or be controlled in varying degrees by a presentation sequence programmed into the hypertext document itself. Readers of hypertext, then, have the option to browse through reading material in a totally open-ended manner corresponding to their interests and needs, or to use a guided exploration built into the hypertext document.

The original idea of hypertext (Nelson, 1974, 1978, 1981) included different types of hypertext forms, from simple links between chunks of related text, to a more loosely structured text navigation system connected to a vast knowledge library including all pertinent information about a subject. Jonassen (1986) described three forms for implementing hypertext: (a) node-link, with chunks of text linked together providing direct access from any piece of text to another; (b) structured, in which the hypertext form serves as a meta-database, controlling access to each of several databases of related information; and (c) hierarchical, similar to structured hypertext, but with content arranged with general concepts broken down into more detailed concepts.

Hypertext, as it evolves, may take on many different forms. Some may prove more effective for particular types of reading material or instructional purposes. A form that is good for recreational or informational reading might not work well as a tutorial or as reference material. With new products described as hypertext beginning to appear in the educational marketplace it is necessary for classroom teachers and other educators to become familiar with this new instructional mode in computer assisted learning.

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Jonassen, D.H. (1986). Hypertext principles for text and courseware design. Educational Psychologist, 21 (4), 269-292.

Nelson, T.H. (1981). Literary machines. Swarthmore, Penn. Available from the author.

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Hypertext Lessons:
A HyperCard Template for Teachers

Hypertext Lessons:
A HyperCard Template for Teachers

Visions of *hyperbooks* (Moursund, 1988), *hypertext*, and other forms of *hypermedia* (Dede, 1987) perhaps foretell the future focus of computer education, but computer using educators need not wait until the future to use hypertext. It is available today in an increasing array of ready to use instructional programs and hypertext authoring systems. HyperCard from Apple Computer is a combination operating system and authoring environment for the Macintosh and currently is the most widely used hypertext system for microcomputers. It is the system detailed in this article.

HyperCard

HyperCard includes its own programming language with full high-level computer language capabilities. Based on a metaphor of note cards, HyperCard programming involves the creation of cards or screens of information which are ordered in files called stacks. HyperTalk, the programming language provided, is used to control presentation of the cards and operations within the stacks.

Although using HyperCard requires programming skills for creation of sophisticated hypertext documents, it is much easier and less time consuming than development of similar material in a more conventional high-level programming language such as pascal, C, or lisp. HyperCard requires a minimum of one megabyte of RAM. A desk accessory, Hyper DA, running on a Macintosh 512, allows applications or programs developed in HyperCard to be viewed.

A Hypertext Template

Developing a template to accomplish similar tasks is a familiar strategy for computer users and programmers. Once a template is built in a spreadsheet, database, or word processing program, one has only to enter new information for each new job. Construction of a hypertext document template likewise makes sense for teachers who want to provide their students with computer assisted instruction through the hypertext format. Using HyperCard, this can be a relatively easy task.

Instructions for creating a simple hypertext document template and subsequent hypertext lessons follow. This is not a HyperCard tutorial. Exact step by step instructions are too lengthy for this article. Those who are somewhat familiar with HyperCard or who have some programming experience and a HyperCard manual should have little trouble, however. It should be kept in mind, that as in any programming task, many ways exist to solve a particular problem. Those included here may not be the most efficient or elegant, but they do work.

Windows, Buttons, and Links

HyperCard, with its metaphor of note cards in stacks, gives a familiar visualization to programming in this authoring environment. One card in a HyperCard stack represents one full screen on the Macintosh. For a hypertext document, each screen (or card) may be thought of as one page in the document. Buttons, cursor sensitive areas, are created on the cards to link them together. The buttons also serve to call windows of varying sizes to overlay a current screen. These windows may contain either text, graphics, or text and graphics together.

Through this system of cards, windows, and buttons, a hypertext document is linked together.

The Template

This template contains ten cards which allows for ten screens of original text. Each card contains links to two graphic windows and two text windows as well as links to the next original page and the previous original page. The last page reconnects to page one (Figure 1).

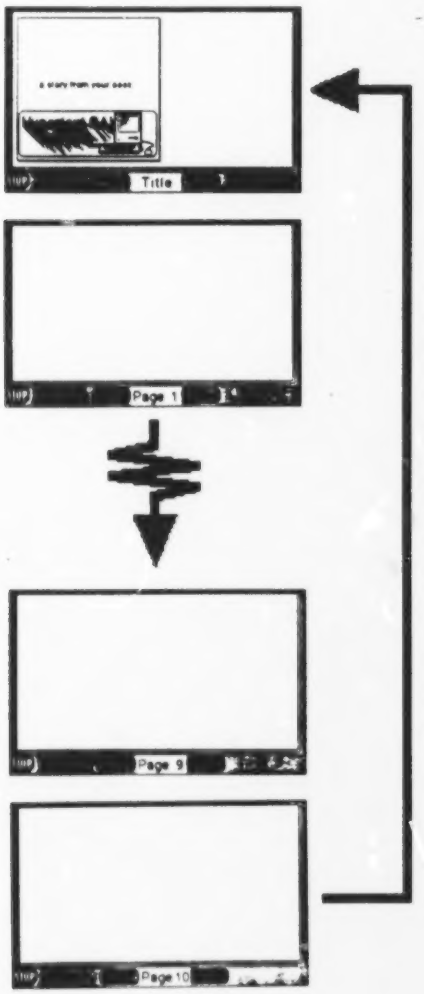

Figure 1. Ten pages of original text are linked sequentially with the last page returning the reader to the beginning. All pages have double links to page forward or backward.

The ten pages (cards) of original text are connected in a sequential order through page-turning buttons. Additional layers of information for each page are available through four windows, two graphic and two text.

This template produces what is perhaps more correctly called a limited or guided hypertext document. While enhancements to the original text via the text and graphic windows on each page are available, there are no referential links between the separate pages. These links would connect or reference related facts or ideas scattered throughout the text. This is a very reasonable option and has been left out only to keep the template simple.

Getting Started. HyperCard programming is accomplished mainly through menu selection of options and immediate mode commands. Starting from scratch is as easy as: (a) selecting NEW STACK from the menu bar; (b) creating a background; and (c) creating the number of cards necessary through menu selection of NEW CARD.

Background. Every page in a hypertext document should bear some similarity to the others in terms of the look and feel of its operational features. This provides a familiar context for reading and learning. A HyperCard stack will have at least one background that is shared by many or all the cards. It can be designed using the built in graphics tool provided in the system but must be done while in the "background" mode. Figure 2 shows a hypertext background. The right and left arrow buttons and the stop button, along with the graphic simulation of stacked pages are features of every card in this stack. Only the white area, where the text for that page will appear, changes from card to card.

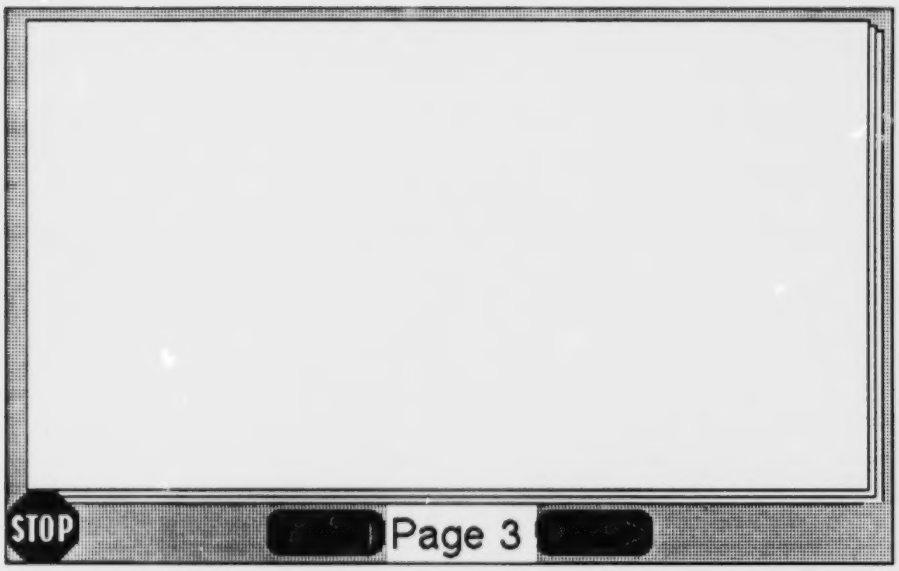

Figure 2. A common background for every page in the hypertext document includes features such as (a) right and left page-turning arrows, (b) a centered page number, (c) a stop button to quit the program, and (d) a white background of simulated stacked papers for the original text of the document.

Cards. Each time a new card is created in a HyperCard stack, it is assigned an ID number unique to that stack. This number is necessary for keeping track of the cards in the stack. For example, the script (HyperTalk code) for a page-turning button must include the card ID number of the destination page (e.g., GO TO CARD ID 2345). It is necessary then to make a listing of these card ID numbers as the cards are created. This is done by menu selection of OPTIONS and then further selection of CARD INFO.

As the first 10 cards, corresponding to the 10 original text pages, are created, their ID numbers must be noted and matched to a page number (e.g., Page 1, CARD ID 2834; Page 2, CARD ID 3730; etc.). This information will be used often as you navigate through the template. When the template is duplicated, the card ID numbers remain the same, so Page 1 in the original template and Page 1 in the 100th copy of the template have the same card ID numbers.

Text Windows. Fields are the HyperCard primary function for displaying text. Fields can be in the background of the stack, and thus appear on every card, or can be specific to a particular card.

This template will use CARD FIELDS exclusively, those specific to one card. Card fields are numbered consecutively from one, up to the number of fields created. Text for the fields is entered in word processor fashion on the screen when the field is active. Again, it is necessary to keep track of what information goes into which field. One way to accomplish this easily is to associate the FIELDS with correspondingly numbered BUTTONS (e.g., Field Button 1 accesses Card Field 1) The information in the card field, then, should be related to the word associated with the like numbered button. Although fields are available in several modes, the SHADOW box, in a non-scrolling mode seems best unless a large amount of text is needed in the field.

Graphic Windows. There is no graphic window function in HyperCard as there is for text. This must be simulated. The simulation is accomplished in the following manner:

1. Copy the text portion of a page using the "marching ants" tool in the TOOLS menu.
2. Create a new card from the EDIT menu. This will put a blank card on the screen with nothing but the BACKGROUND visible.
3. Paste the text from the original page onto the new page.
4. Using the graphics tools create an empty box where you want the graphic window to appear. A shadow box in the upper right corner is a good spot.
5. Copy the graphic you want from the SCRAPBOOK and paste it into the empty box you just created.
6. Note the CARD ID number of the new page.
7. Return to the original page.

The graphic window simulation is effected by a BUTTON script which calls the new card to replace the original. Since the only thing different in the two cards is the graphic box, it appears that the box is an overlay to the original page rather than a full page replacement. Similarly, to hide the graphic window, the script calls the original page back. This appears to make the window disappear. (Figure 3).

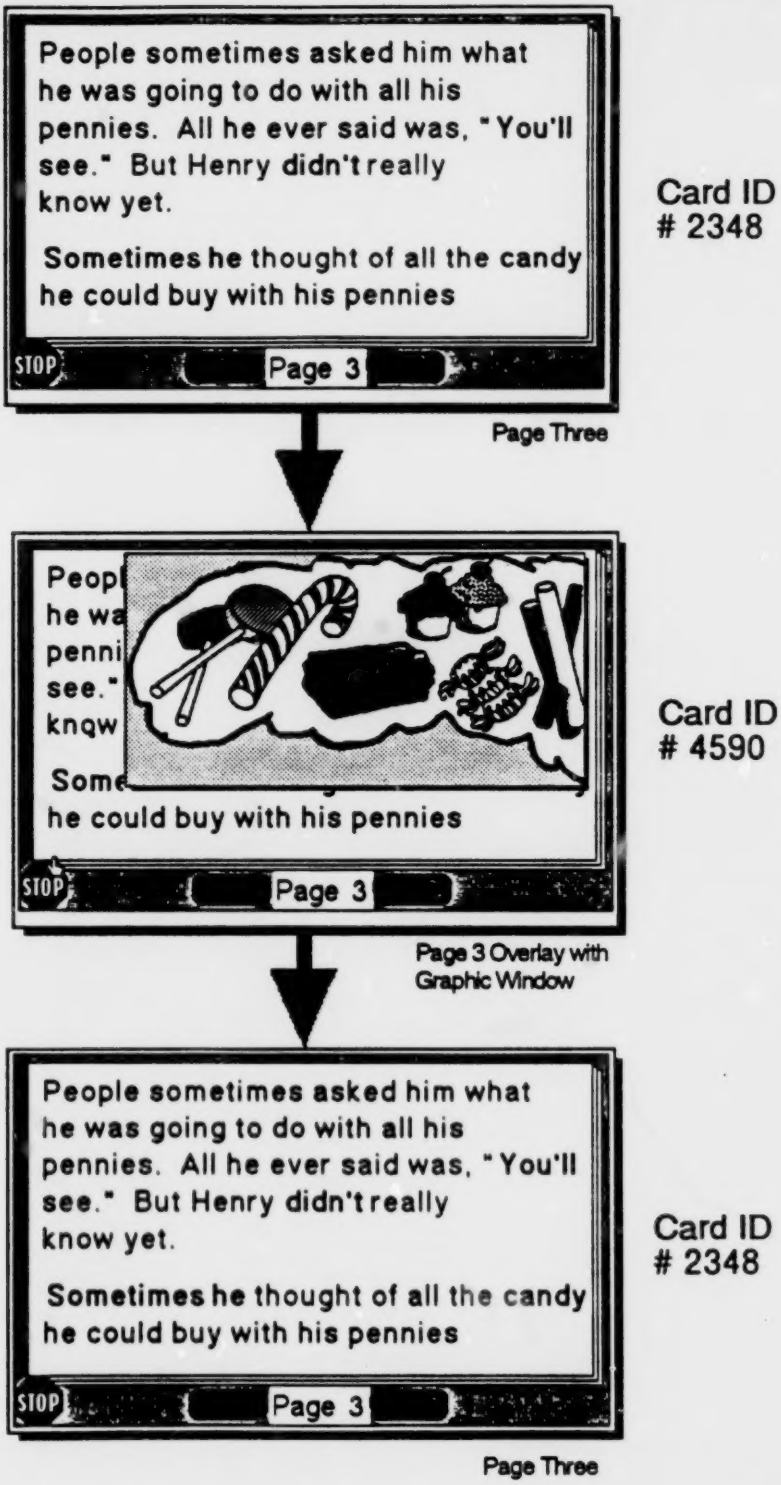
People sometimes asked him what he was going to do with all his pennies. All he ever said was, "You'll see." But Henry didn't really know yet.
Sometimes he thought of all the candy he could buy with his pennies
STOP
Page 3
Page Three
Card ID # 2348
he could buy with his pennies
STOP
Page 3
Page 3 Overlay with Graphic Window
Card ID # 4590
People sometimes asked him what he was going to do with all his pennies. All he ever said was, "You'll see." But Henry didn't really know yet.
Sometimes he thought of all the candy he could buy with his pennies
STOP
Page 3
Page Three
Card ID # 2348

Figure 3. A graphic window for Page Three (card ID #2348) is simulated by a three step process: (a) making a copy of Page Three on another card (card ID #4590), (b) pasting the graphic desired as a window onto the copy of Page Three, and (c) replacing Page Three with the copy to simulate the window appearing and vice versa to make the window disappear.

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Buttons. Buttons are the real workers in HyperCard. The scripts, or HyperTalk programming code, associated with the buttons are very powerful. Buttons are created from the OBJECTS menu and the NEW BUTTON command. Buttons can be many different shapes or fully transparent. A transparent button, overylaying any word, phrase, graphic, or graphic part, becomes a very powerful hypertext function. Unfortunately, buttons come only in the traditional rectangular shape familiar in most Macintosh graphic applications, although they are fully adjustable in size and dimension. The scripts associated with the buttons are activated by the mouse click operations of mouseUp (releasing the mouse button) or mouseDown (clicking the mouse button down). MouseUp is the most widely used.

Template Directions

A hypertext document template is now ready to be built following these directions.

Create the Cards

1. Open HyperCard.
2. Go to FILE menu and select NEW STACK; name it; unselect the COPY CURRENT BACKGROUND box; select NEW.
3. Go to EDIT menu and select BACKGROUND.
4. Go to TOOLS menu and use these MacPaint-like graphic tools to create a background. Plan this out ahead to save time.
5. Get the MESSAGE BAR with COMMAND-M; type SET USERLEVEL TO 5, (this puts you into scripting mode).

6. Go to OBJECTS menu and select CARD INFO; make note of the card ID number. (This is the card identification number for Page 1 of the hypertext document). Click OK.
7. Go to EDIT menu and select NEW CARD. (A new card identical to the previous one will appear.)
8. Go to OBJECTS menu and select CARD INFO as before and note the card ID number. (This is the card identification number for Page 2).
9. Repeat steps 7 and 8 until you have 10 cards. Be sure to note the CARD ID NUMBER each time you create a new card and list it somewhere with its corresponding page number.

Make Additional Cards to Simulate Graphic Windows

Each original text page will have two graphic windows and two text windows. For ten pages of original text this means 20 additional cards will be created for the graphic window simulations. Be sure to list the CARD ID NUMBERS for the two new cards next to the page to which they will be connected.

(e.g., Page 1 id#2834 window 1 id#6338
window 2 id#6573

Page 2 id#3730 window 1 id#7030
window 2 id#7249)

Follow steps 7 and 8 in the instructions for creating cards until 20 additional cards are created and noted as shown above.

Create the Fields for Text Windows

1. Get the message bar with COMMAND-M; and type GO TO CARD ID (then the number for Page 1 from your list--e.g., GO TO CARD ID 2834 and press return).
2. Go to the OBJECTS menu and select NEW FIELD; double click on the field when it appears on the screen; type FIELD 1 as the name; select SHADOW; click on FONT; choose font and size; then select OK.
3. Move and resize the field on the page.
4. Repeat Steps 1 and 2 above, but naming the second field FIELD 2.
5. Do this for each of the 10 original text pages in the template. Use the instructions in Step 1 to move from page to page.

Create the Buttons

1. Get the message bar with COMMAND-M; and type GO TO CARD ID (then the number for Page 1 from your list--e.g., GO TO CARD ID 2834 and press return).
2. Go to OBJECTS menu and select NEW BUTTON; double click on the button; name the button GRAPHIC 1; choose TRANSPARENT and AUTO HILIGHT; then click on the SCRIPT box.
3. Between the script lines ON mouseUP and END mouseUP type in the following script:

   GO TO CARD ID (ID # of window 1 of page 1)

   WAIT UNTIL THE MOUSECLICK

   GO TO CARD ID (ID # of page 1)

   Line 1 calls the graphic window page.

Line 2 holds the page until the mouse is clicked again.

Line 3 calls the original page back into view.

4. Repeat Steps 2 and 3 above, but naming the button, GRAPHIC 2, and changing the CARD ID NUMBER in Line 1 of the script to that of Window 2 of Page 1.
5. Go to OBJECTS menu and select NEW BUTTON; double click on the button; name the button FIELD 1; choose TRANSPARENT and AUTO HILIGHT; then click on the SCRIPT box.
6. Between the script lines ON mouseUP and END mouseUP type in the following script:

    SHOW CARD FIELD 1

    WAIT UNTIL THE MOUSECLICK

    HIDE CARD FIELD 1

    Line 1 calls the text window.

    Line 2 holds the window until the mouse is clicked again.

    Line 3 hides the text window.

7. Repeat Steps 2 and 3 above but naming the button FIELD 2, and changing the FIELD NUMBERS in Lines 1 and 3 of the script to FIELD 2.
8. Resize and stack these buttons somewhere convenient on the page.
9. Do this for each of the 10 original text pages in the template. Use the instructions in Step 1 to move from page to page.

Create Page Turning Buttons

1. Get the message bar with COMMAND-M; and type GO TO CARD ID

(then the number for Page 1 from your list--e.g., GO TO CARD ID 2834 and press return).

2. Go to OBJECTS menu and select NEW BUTTON; double click on the button; name the button NEXT PAGE; choose ROUND RECTANGLE and AUTO HILIGHT; then click on the SCRIPT box.
3. Between the script lines ON mouseUP and END mouseUP type in the following script:

   GO TO CARD ID (ID # of the next page)

4. Repeat Steps 2 and 3 above but naming the button PREVIOUS PAGE, and changing the CARD ID NUMBER in the script to that of the page just preceding. In the case of Page 1 which has no preceding page, you may want to put the CARD ID of Page 10. This connects the start and the end of the document in a loop.
5. Position and resize these buttons in appropriate spots on the page.
6. Do this for each of the 10 original text pages in the template. Use the instructions in Step 1 to move from page to page. Buttons can be copied and pasted from page to page.

The template is finished. From the Macintosh Finder, duplicate the template and use the new copy to begin constructing a hypertext document. With this template, some creative ideas, and an original text that you want to adapt to a hypertext document, an effective piece of instructional or informational software can be built.

A Hypertext Document

Document building is broken down into nine basic steps. Each step is listed with annotations, suggestions, and discussion below.

Enter Text of the Original Document. HyperCard has two text modes. There are the text fields which remain dynamic much like text in a word processor document, and there is the graphic mode of text presentation. The original text should be entered on the cards in the graphic mode using the TOOLS menu. Care must be taken in entering this text as it is not an editable file, but rather a graphic. Enter the text in an extended typeface but without any boldface or italics. To choose a font or style, first select the text function from the TOOLS menu. COMMAND-T presents a selection window for font, size, and type style. Make the appropriate selections and return to fill the page with text. Continue page by page until the document has been entered. Take care to not split meaningful units of text or syntactic structures between pages.

Decide Which Words Will Be Hyper-enhanced. Based on the intent of the hypertext document, a decision must be made as to which words or pictures (if you decide to add pictures to the original pages) will have a link to a window. A hypertext lesson from a content area text or basal reader might use the new vocabulary words, important people or events, timelines, etc. These decisions are the basis for the instructional design of CAI lessons or the focus of an informational document.

Decide the Type of Enhancements. Graphic windows, explanatory or clarifying text, graphic or text combinations, or computer generated speech or music are all options for enhancements. Text enhancements will be assigned

FIELD buttons, and graphic or graphic/text enhancements will use the GRAPHIC buttons. Speech can be added to either of the button types or used alone.

Boldface the Words Which Will Be Buttons. Return to the text mode of the graphics tool. Use COMMAND-T to return to the font and style window. Choose the same font and size as before, but in boldface, non-extended type style. (Boldface and regular spacing between letters takes up the same space horizontally as non-boldface with extended spacing between letters.) Returning to the page of original text, the words which have been chosen for buttons are darkened by typing over them in the boldface style. This is a key for the reader that a window exists for that word.

Position Buttons and Size Them Over the Words. The four buttons that were created in the template are stacked somewhere on each original text page. To relocate them over the boldface words, the BUTTON mode from the TOOLS menu first must be activated. It is the middle-top square next to the BROWSE (finger pointing) mode box. Selecting a button now causes the "marching ants" to mobilize. The button can be moved by the CLICK AND DRAG method to the proper word where it can be resized by grabbing a corner and adjusting it. The name of the button now overlays the word. Double click on the button and un-select SHOW NAME and click on OK. The button name is now invisible. Returning to BROWSE mode (click on the finger box under the TOOLS menu) makes the entire button disappear. It is now active and ready to work.

Enter Text into Text Fields. The two FIELD buttons on each page are now linked to two corresponding but empty text fields. To enter text into the fields, the FIELD mode from the TOOLS menu first must be activated. It is the

box on the top-right, next to the BUTTON mode box. Now get the message bar (COMMAND-M), enter SHOW CARD FIELD 1, and press return. Card Field 1 will now show on the screen.

To enter text, activate the BROWSE box in the TOOLS menu and place the cursor into the top-left corner of the FIELD box. Enter your text into the field. The field may be re-sized by activating the FIELD box again and grabbing a corner of the field. This may be necessary to make the field size fit the amount of text. When finished, activate the BROWSE box on the TOOLS menu and type into the message bar HIDE CARD FIELD 1. Follow the same process for Card Field 2.

Create Graphic Windows. There is no graphic window function in HyperCard as there is for text. This must be simulated. First, copy the text portion of the original text page using the "marching ants" tool in the TOOLS menu and the EDIT menu COPY command. Next, check your list for the CARD ID number of Window #1 for this page. Get the message bar (COMMAND-M) and enter GO TO CARD ID (the number from the list). An identical page, though empty of text, appears.

Paste the text from the original onto the new page with the EDIT menu PASTE command. Using the graphics tools create an empty shadow box where you want the graphic window to appear. The upper right corner is a good spot. Copy the graphic you want from the SCRAPBOOK (clip art or your own design) and paste it into the empty box you just created. Return to the original page by entering in the message bar, GO TO CARD ID (the number of the original page).

Putting Sounds into Hypertext. HyperCard handles playing sounds, voices, and music very well. The Macintosh SND (sound) resource can be

activated from a HyperCard stack with the PLAY command followed by the SND name or number. ResEdit, a resource editor from Apple Computer, allows SND resources to be easily added or deleted from stacks. A device such as the MacRecorder, from Farallon Computing, creates SND resources through a microphone or a standard audio output device. It might be noted that SND resources require lots of disk space.

A word of caution for users without hard disk drives. The SND resources, when read from a 3.5 inch disk and channelled through the HyperCard PLAY command, can be full of distortion. This distortion seems to be related to the slower read time on the 3.5 inch medium. The distortion can be circumvented by adding a WAIT command directly after the PLAY command in the script. The longer the sound being played, the longer the WAIT command should be.

Final Check. Browse through the stack, stopping on each page and utilizing every button on the page. Make sure the windows are linked to the proper words and that transitions are smooth.

Conclusion

Hypertext appears to hold many possibilities for educational use, from a highly unstructured document for exploring just about any subject, to a more specific, directed teaching tool such as a study guide for a content area text or a basal reader supplement. The hypertext format of layered text accessed in a non-sequential fashion by the reader, provides dynamic, interactive instruction very different from traditional computer assisted instructional programs.

Although most hypertext development is centered around the Macintosh computer, not yet a common machine in the public schools, computer using

educators have already begun to explore the seemingly endless possibilities that hypertext opens up. Findings from a recent study at the University of Washington indicate that hypertext study guides are an effective tool for high school remedial and learning disabled students (Higgins, 1988). Preliminary findings from a related study with elementary school students support the use of hypertext computer assisted reading material as a supplement to teacher directed instruction for low achieving students (Higgins & Boone, 1989).

Whether the subject matter is from a high school social studies text or an elementary school basal reader, the hypertext format appears an effective instructional mode for students of varying ages and ability levels. It is a new and exciting concept in the field of computer use in education.

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Hypertext Computer Study Guides And the Social Studies Achievement Of Students with Learning Disabilities, Remedial Students, and Regular Education Students

Hypertext Computer Study Guides And the Social Studies Achievement Of Students with Learning Disabilities, Remedial Students, and Regular Education Students

Hypertext, a new concept in the design of computer assisted instructional (CAI) materials, is an application for non-sequential, computer-based text and information retrieval that first was envisioned in 1945 (Bush, 1945). Since this capability for microcomputers became widely available in 1987, interest in hypertext educational uses has been growing rapidly. This interest has resulted in an increase in the number of magazine and journal articles published, presentations at educational conferences, and hypertext educational software programs available for classroom use. Hypertext as an educational medium is very different from most traditional computer assisted instructional software, offering a new format for providing instruction and information via a computer.

A screen or page in a hypertext document might be thought of as a composite of several sheets of transparency film overlaying one another, the top layer not only providing the original text to be read but also serving as a menu for accessing additional information, such as getting help with unknown words, or following tutorial strategies for building comprehension. Words, parts of words, graphics, or parts of graphics provide more information than what first appears on the surface layer of the screen. Positioning the cursor on specific areas of the top layer hypertext page makes the appropriate layers beneath accessible. For example, selecting a word with the cursor could give a choice of the word's definition, pronunciation, etymology, or provide a graphic related to the word. Further button selection could take the user to subsequent layers of information (see Figure 1).

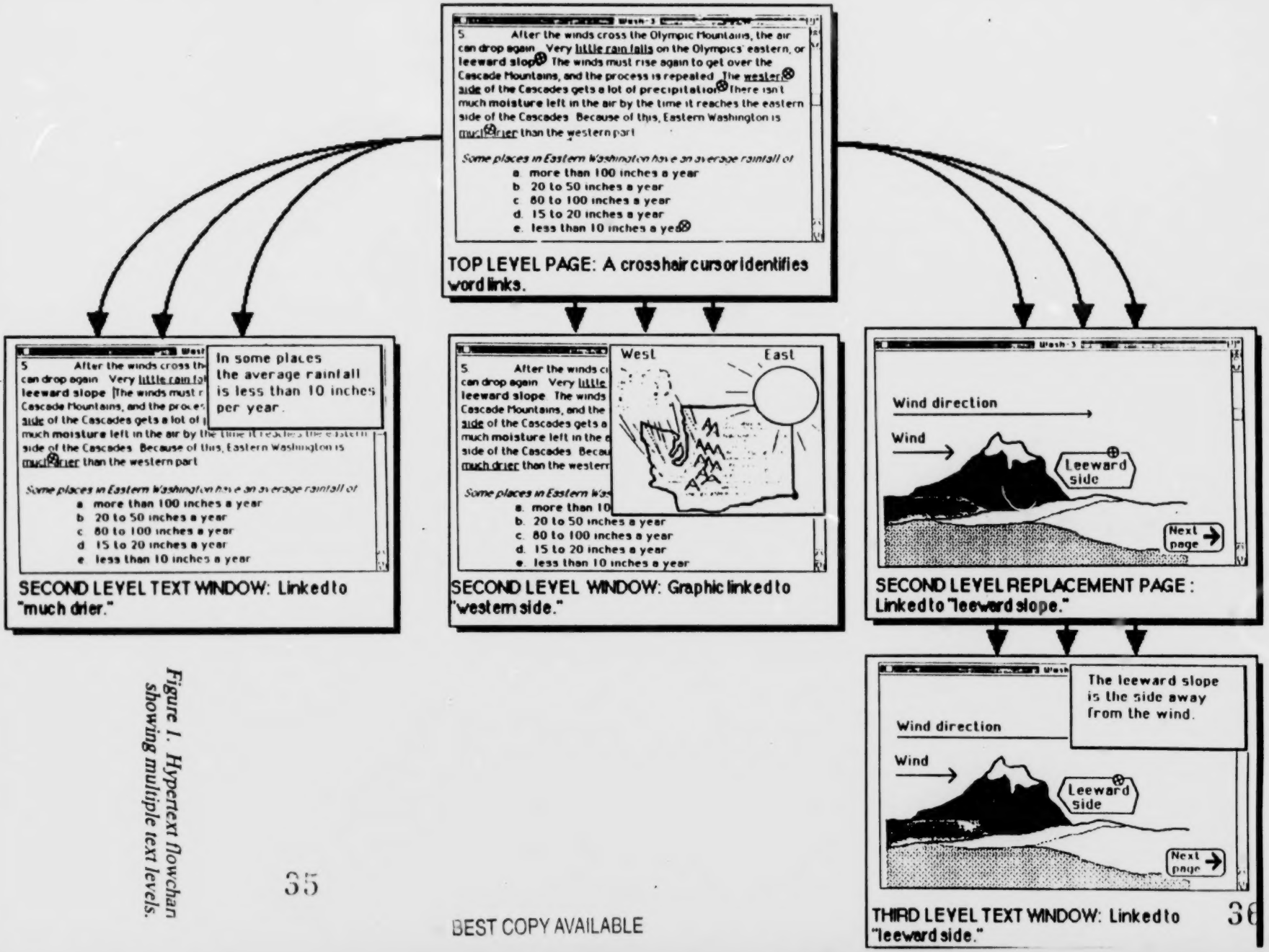
5 After the winds cross the Olympic Mountains, the air can drop again. Very little rain falls on the Olympics' eastern, or leeward slope. The winds must rise again to get over the Cascade Mountains, and the process is repeated. The western side of the Cascades gets a lot of precipitation. There isn't much moisture left in the air by the time it reaches the eastern side of the Cascades. Because of this, Eastern Washington is much drier than the western part.
Some places in Eastern Washington have an average rainfall of
a. more than 100 inches a year
b. 20 to 50 inches a year
c. 80 to 100 inches a year
d. 15 to 20 inches a year
e. less than 10 inches a year
TOP LEVEL PAGE: A crosshair cursor identifies word links.
In some places the average rainfall is less than 10 inches per year.
SECOND LEVEL TEXT WINDOW: Linked to "much drier."
West
East
SECOND LEVEL WINDOW: Graphic linked to "western side."
Wind direction
Wind
Leeward side
Next page
SECOND LEVEL REPLACEMENT PAGE: Linked to "leeward slope."
The leeward slope is the side away from the wind.
THIRD LEVEL TEXT WINDOW: Linked to "leeward side."

Figure 1. Hypertext flowchart showing multiple text levels.

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Hypertext Flow Chart

The computer screen shown at the top of the flow chart in Figure 1 is the original text layer of a hypertext page. At the second level of the flow chart are screens that are linked to specific words in the top level screen. These linked words are often referred to as buttons.

The screen on the left. This screen is linked to the words "much drier." That is, additional related information appears in a text window when the words "much drier" are chosen by cursor selection. This second-level window may be viewed until the reader clears it from the screen with additional cursor selection.

The middle screen. This also shows a second-level window that is linked to the phrase "western side." Unlike the window in the previous page, this window is a picture rather than text. Cursor selection clears the new window returning the reader to the original page.

The screen on the right. This is a complete replacement screen rather than a window, and is linked to "leeward slope." It is different from the other two second-level screens in that it also contains buttons, or linking words, to a third level.

The screen at the right-bottom. This shows a screen with a third-level window that is linked to the caption "leeward side" in the picture shown on the second-level screen. Clarifying text defines the term "leeward side." Similarly, selection of the other two terms, "wind" and "wind direction," would produce corresponding windows with clarifying text.

The current shift in CAI research is from instructional medium comparison studies to those that concentrate on specific conditions that may affect student

learning. Therefore, the two studies described in this article address not only the impact of the microcomputer in isolation, but also the interaction of the microcomputer and other specific aspects of the educational environment. Particular conditions that may have an impact on microcomputer and CAI use have been identified in the literature and were included in the design of this research. They are (a) computer impact by content area (Becker, 1987), (b) computer impact as it relates to the skill level of the student (Kulik, Bangert, & Williams, 1983), (c) retention of achievement gains by the student (Kulik, Kulik, & Cohen, 1980), (d) the nature of the computer use (Waugh & Currier, 1986), and (e) the selection of CAI software (Carnine, 1984).

Content area. The computer assisted instructional materials designed for these two studies provided highly interactive instructional activities in social studies. Less CAI research has been conducted in high school academic areas such as English composition, social studies, and science, (Becker, 1987) than research into teaching about computers (e.g., computer literacy) (Becker, 1983).

Student skill level. These two studies included regular education students as well as students with learning disabilities and remedial students. The effect of the treatments for the three groups of students was specifically addressed.

Retention of achievement gains. Retention data in these two studies were collected (a) immediately following completion of the daily lesson, (b) at the end of the 10 day instructional period, and (c) two weeks after the end of the instructional period. Few studies have researched the effects of CAI on student retention of achievement gains.

Nature of computer use. These two studies investigated the use of hypertext computer assisted study guides both as a substitute and as a supplement to teacher presented instruction. Research suggests that properly designed CAI can produce significant achievement gains in students when used as a supplement to traditional instruction (Winkler, Shavelson, Stasz, Robyn, & Feibel, 1984) or as a substitute for traditional instruction (Collins, Carnine, & Gersten, 1987).

Software selection. The effectiveness of a CAI system largely depends on the appropriateness of the curricula materials it presents for the student population it serves. Much of traditional CAI software is not directly related to the other instructional materials used in the classroom (e.g., basal readers and content texts). Because teachers prefer to use computer software that relates directly to what they are already doing instructionally (Mokros & Russell, 1986; Naiman, 1987), traditional materials need to be adapted to the CAI format. The hypertext format, written in the *Guide* (Owl International, 1987) authoring system for the Macintosh computer, was chosen for the CAI lessons developed for this study. These lessons provided the students with a dynamic, non-linear reading environment offering additional information about words and concepts from their social studies text. The hypertext lessons provided the students with access to special enhancements within a single, familiar context. This differs from traditional CAI which often presents lessons on isolated skills not specifically related to textbook content or the teacher's instructional style.

Three classes of Washington State History participated in Study 1. This study took place over a 10 day period and involved students randomly assigned to three different treatment groups. Study 2 explored the use of hypertext computer

assisted study guides as a follow up to teacher presented instruction. This study, a small group A-B-A design, was conducted to ascertain if the computer assisted hypertext study guides could be used to bring lower-achieving students closer to a passing grade. Although different in nature, the two studies used the same materials and procedures.

Study 1

The purpose of this study was to develop highly interactive, computer-based study guides designed to increase the amount of instructional time for students with learning disabilities (LD), remedial students, and regular education students within a mainstreamed, high school social studies classroom. Important concerns within this setting were (a) increasing instructional time without increasing the demands on the teacher's time, and (b) creating a system that could offer access to new curriculum or enhance an already established curriculum. Computer assisted instruction using the hypertext format was chosen as the means for integrating this additional instructional time.

Method

Setting and Students

The study was conducted in a middle to upper-middle class school district north and adjacent to Seattle, Washington. The study took place in the social studies classroom and in the Macintosh computer lab located next to the classroom. The Macintosh computer lab contained 25 Macintosh 512 computers.

Forty 9th-grade students enrolled in Washington State History participated in this study (see Table 1). There were 10 students with learning disabilities, 15 remedial students, and 15 regular education students. The 40 students who

participated in this study were taught by the same teacher who had been teaching Washington state history for 15 years and remedial classes for two years.

Remedial students are defined by this school district as non-handicapped students scoring below the 35th percentile on both quantitative and verbal subtests of the Metropolitan Achievement Test (Prescott, Balow, Hogan, & Farr, 1984). In Washington, students with learning disabilities in grade seven and above are defined as students whose intellectual functioning is above that specified as mentally retarded and who exhibit a severe discrepancy between intellectual ability and academic achievement in one or more of the following areas: oral expression, listening comprehension, written expression, basic reading skill, reading comprehension, mathematics calculations, and mathematics reasoning. A severe discrepancy is defined as a functioning level of two-thirds or below expected performance and a functioning level below chronological age/grade in one or more of the seven areas described in the definition of a student with learning disabilities. Socio-economic status, overall and specific achievement scores, and IQ information were not available from the school district. While specific reading levels for the students were unavailable, informal observation during the pilot test phase gave no indication that students had any serious difficulty in reading the materials presented to them.

Students participating in the study completed three different researcher-designed surveys. These included (a) a Demographic Survey to ascertain the level of each student's previous exposure to computers, (b) an Attitude Toward Learning Survey (before and after intervention) to identify various attitudes students had about learning, and (c) an Attitude Toward Computers Survey (before and after

intervention) to identify attitudes toward computers in general and computers used in learning specifically.

The Demographic Survey indicated that over half the students in the study had computers at home, that they used computers at school, and that they played video games on a regular basis. The use of computers at home and at school averaged about two times a week for students while the typical use of video games ranged from once a week to 14 times a week.

The Attitude Toward Learning Survey did not indicate any significant differences in student attitudes toward learning or toward Washington State History from the beginning to the end of the study. It is important to note that neither pre- nor post-intervention attitudes of the students toward learning Washington State History were negative. The majority of the students indicated that (a) it was important to do well in social studies, (b) they enjoyed learning about new things, (c) they learned best when they had the opportunity to interact with the material to be learned, (d) they cared about the grade they got in Washington State History, and (e) learning about Washington State History was important.

A positive attitude toward computers was reflected by a majority of the students on the Attitude Toward Computers Survey. While no change in student attitudes from pre-intervention to post-intervention was found, the majority of the students selected responses indicating that (a) they would prefer to learn Washington State History using a computer, (b) reading from a computer screen was easier than reading from a textbook, (c) computers made learning easier, (d) computers made learning fun, (e) computers made the class more interesting, (f)

school would be better if more teachers used computers, and (g) computers could help in getting better grades in school.

Materials

Textbook. The textbook used in this study was The Washington Story: A History of Our State (Pelz, 1979). The first two chapters of the textbook were selected for this study. These chapters were broken down into 10 reading sections which varied in length from 500 to 700 words. Readability of the text used in the lessons was determined to be at the junior high school level (Flesch Index of 68).

Guide, a Hypertext Authoring System. Guide was the hypertext authoring system for the Macintosh Computer used in this study. Hypertext is the text presentation principle upon which the study guides were based. In order to visualize the hypertext study guides, it is important to understand the hypertext concept.

Three hypertext functions were used in designing the study guides (see Figure 2). The purpose of the note function is to create short explanatory notes. Notes, indicated in the text by being underlined, were used by students to access information in the second or third layers of the text.

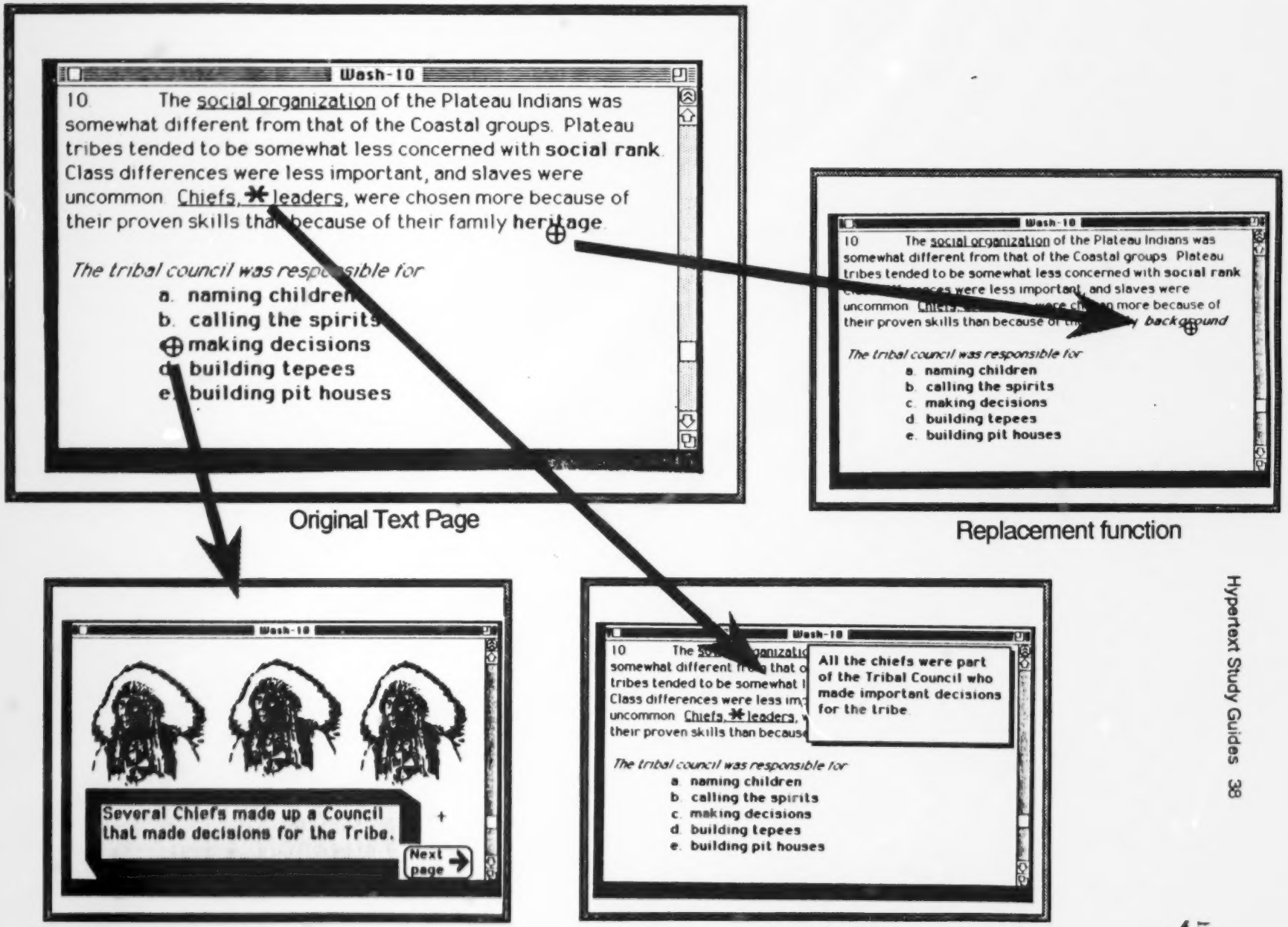
Wash-10
10 The social organization of the Plateau Indians was somewhat different from that of the Coastal groups. Plateau tribes tended to be somewhat less concerned with social rank. Class differences were less important, and slaves were uncommon. Chiefs, leaders, were chosen more because of their proven skills than because of their family heritage.
The tribal council was responsible for
a. naming children
b. calling the spirits
making decisions
building tepees
building pit houses
Original Text Page
Wash-10
10 The social organization of the Plateau Indians was somewhat different from that of the Coastal groups. Plateau tribes tended to be somewhat less concerned with social rank
uncommon Chiefs, more because of
their proven skills than because of background
The tribal council was responsible for
a. naming children
b. calling the spirits
c. making decisions
d. building tepees
e. building pit houses
Replacement function
Wash-10
Several Chiefs made up a Council that made decisions for the Tribe.
Next page
Inquiry function
Wash-10
All the chiefs were part of the Tribal Council who made important decisions for the tribe.
The tribal council was responsible for
a. naming children
b. calling the spirits
c. making decisions
d. building tepees
e. building pit houses
Note function

Figure 2. Hypertext functions used in the study guides.

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The replacement function allowed the student to control the exposure of the text. When activated, the selected text was replaced by a clarifying segment of text or a related graphic. Replacement functions were indicated in the text by boldface type.

The inquiry function was used to control student movement through the multiple choice questions. Students could not move on to the next screenful of text until they had answered the multiple choice question correctly. An incorrect answer re-routed the student back to the appropriate text and the multiple choice question. A correct answer was reinforced with text and graphics directly related to the question. Students were then allowed to continue to the next page of the study guide.

Hypertext Computer Assisted Study Guides. The study guides were designed by taking into consideration the ingredients of good screen design as identified by Grimm (1983) and Heines (1983). These included the avoidance of screen scrolling, the use of titled pages when appropriate, functional organization of information, and uncrowded screens.

The development of the hypertext study guides began as a paper and pencil task. Each 500 to 700 word passage was divided into 50 to 100 word sections. The cooperating teacher's suggestions on vocabulary, concepts, charts, maps, or graphics were used as enhancement buttons in the study guide.

The resulting hypertext study guides were from nine to thirteen screens of text, depending on the length of the reading passage and the number of words, graphics, concepts, maps, or charts included in the lesson. Each study guide contained eight multiple choice questions that were presented on the same screen as

the text to which they related. Every question had five answers from which to choose, with feedback being provided as to the accuracy of the choice. These eight questions became a part of the daily paper and pencil multiple choice quiz given at the end of the each lesson. A lesson was designed so that a student could complete it during a 15-minute period.

A screen in the hypertext study guide was made up of text (with word or graphic enhancements); text plus a multiple choice question (with word or graphic enhancements) ; or a graphic (with word enhancements). Enhancements could be a definition, graphic, or further clarification of the top layer word. Students accessed the enhancements by placing the cursor on the word or graphic and clicking the mouse. The enhancement appeared on the screen for the student to view. The student returned to the original text by clicking the mouse again.

Teacher Presented Instructional Materials. Materials presented by the teacher were designed to contain the same information as the hypertext computer assisted study guides. These materials were (a) teacher lecture, (b) the identified reading passage, and (c) a student worksheet containing the eight multiple choice questions included in the hypertext study guides. A protocol containing directions for the teacher was developed for each lecture.

Daily reading passages in the lecture condition were the same as those adapted for the hypertext study guides. The students were assigned the 500 to 700 word reading passage following the teacher's lecture.

Worksheets for the students were made up of eight multiple choice questions. These were the same eight questions contained in the hypertext study guides and that appeared on the daily quizzes.

Pretest. A 50-item multiple choice test, drawn from the daily quizzes, was administered prior to the study. Thirty-five of the questions were factual and 15 were inferential. Each question had five possible answers from which to choose.

Daily Quizzes. The daily measures employed in this study were multiple choice quizzes based on each reading passage. Quiz items were prepared following guidelines for multiple choice tests suggested by Sarnacki (1979). Each quiz contained 25 questions, 20 factual and 5 inferential. The same eight questions contained in the hypertext study guides and the student worksheets appeared on the daily quizzes.

Unit and Retention Tests. The unit test was the pretest readministered to the students the day after the completion of the 10 day Washington State history unit. The retention test was the unit test readministered to the students two weeks after the unit test.

Design and Procedures

Phase One. This phase consisted of two one-hour sessions of student training in the operation of the Macintosh computer, the utilization of the mouse input device, and the hypertext software. A computer assisted hypertext lesson concerning Greek mythology was developed for this training session.

Phase Two. A three day pilot study was conducted during this phase. The three hypertext computer assisted study guides and teacher presented lessons in Phase Two were designed incorporating Canadian history as the area of instruction. Students were randomly assigned to one of three treatment groups for the pilot study (a) lecture, (b) lecture / computer study guide, and (c) computer study guide.

Each treatment condition involved a 30-minute instructional period followed by a 10-minute multiple choice quiz. Students assigned to the lecture condition listened to and took notes from a lecture given by the teacher for 15 minutes. The students were then assigned a reading passage from the book and given a worksheet containing eight multiple choice questions to complete in the last 15 minutes of the instructional period. They were allowed to use their notes or the book to complete the worksheet. Prior to taking the quiz, students turned in their notes and worksheets. This was done so that students would not be tempted to refer to them when taking the quiz.

Students assigned to the lecture / computer study guide condition listened to and took notes from the lecture given by the teacher for 15 minutes. They then turned in their notes and moved to the computer lab. There, they went through the hypertext study guide as many times as possible for the remaining 15 minutes of the instructional period. Progression through the hypertext study guide involved reading the text on the screen, selecting enhanced words, reading the notes behind the enhancements, and moving on to the next screen of text. Students were able to pace their movement through the lesson. Responses to the multiple choice questions generated feedback and routed students back to the question or to the next screen of text as appropriate.

Students in the computer study guide condition worked with the hypertext study guide for the entire 30 minutes of the instructional period. These students were also able to go through the study guide as many times as possible in the allotted time.

Phase Three. This phase was a Washington state history instructional unit conducted over 10 consecutive school days. The students again were randomly assigned to the three treatment groups.

Phase Four. This was the posttesting phase of Study 1. A 50-item, multiple choice test that had been administered as a pretest in Phase One was given the day following the completion of the instructional unit. Two weeks after the conclusion of the instructional unit, the 50-item, multiple choice test was readministered as a retention measure.

Scoring and Reliability

Data included results of the 10 daily quizzes, the Washington state history pretest, unit tests, and the retention tests. All quizzes and tests were machine scored.

Reliability data on the daily teacher lecture were taken in order to measure the extent to which the lecture protocol was followed. This ensured that all treatment groups received the information necessary to complete the tests and quizzes.

Results

Test Scores

The data analyzed in this study were the scores from a pretest, 10 daily quizzes, a posttest, and a retention test. A randomized block design was chosen to determine treatment and block effects. The blocking variable was the educational group into which students had been classified (i.e., LD, remedial, regular education). The three treatments used in the study (i.e., lecture, lecture/computer study guide, and computer study guide) were randomly assigned within the blocks.

Each set of scores (pretest, posttest, retention, and daily quiz) was analyzed by means of a 3 X 3 ANOVA. Each analyzed cell entry of the 3 X 3 matrix was an average over its respective row and column headings. For each matrix, the three rows represent the educational groups in the order of LD, remedial, and regular education. The three columns represent the treatment groups in the order of lecture, lecture/computer study guide, and computer study guide.

The pretest scores were analyzed first (see Table 2). There was a significant educational group effect but no significant treatment effect. Since no treatment was administered, no significant treatment effect was predicted for the pretest scores. The pretest analysis showed that there were three significantly different educational groups. The means of the pretest scores were rank ordered from lowest to highest for educational group; LD being the lowest, remedial next, and regular education the highest. To test for significant differences among the three educational group means, the Newman-Keuls test was performed with alpha level set at .05.

For students receiving instruction by means of lecture, both regular education students and remedial students had significantly higher pretest scores than the students with learning disabilities. In the lecture/computer study guide group, the regular education students did significantly better than the students with learning disabilities and the remedial students. There were no significant differences between any pair of educational groups among the students who received instruction from the computer study guide. When differences between educational groups were examined without any treatment group distinction, all three

pairs (LD vs. regular education, LD vs. remedial, and remedial vs. regular education) of educational group means showed significant differences.

Each set of daily quiz scores was analyzed in the same manner as described above. On days 1 through 10 quiz scores for the computer study guide group were better than the other two groups; on days 1, 2, 5, 7, 8, and 10 the quiz scores of the lecture/computer study guide group were better than the lecture group; and, on days 3, 4, 6, and 9 the lecture group quiz scores were better than the lecture/computer study guide group (see Table 3).

Analyzed separately, students with learning disabilities in the computer study guide treatment group showed higher quiz scores than those in the lecture or lecture/computer study guide groups on seven days of the study (days 1, 2, 3, 5, 8, 9, and 10) (see Table 4). On days 4, 6, and 7, the students with learning disabilities who received the lecture instruction had higher quiz scores than the other two treatment groups. Remedial students in the computer study guide treatment group had higher quiz scores than remedial students in the lecture or the lecture/computer study guide groups on eight days (days 1, 3, 4, 5, 6, 7, 8, and 9). Quiz scores on days 2 and 10 were highest for remedial students in the lecture/computer study guide group. The highest quiz scores for regular education students varied across all three treatments (a) computer study guide highest on days 1, 2, and 7, (b) lecture highest on days 3, 9, and 10, and (c) lecture/computer study guide highest on days 4, 5, and 6. On day 8 the scores for lecture and the computer study guide treatments were the same for the regular education students.

A significant educational group effect was found on days 1, 5, and 8; and, a significant treatment effect was detected for day 1. R-squared values ranged from 0.5579 (day 10) to 0.9615 (day 1). The three highest R-squared values were associated with the ANOVAs done on days 1, 5, and 8 (i.e., on the days for which significant effects were found). Tukey's 1df test for nonadditivity was performed for each set of quiz scores and residual plots were drawn. These checks allow the assumption of an additive model with normally distributed, independent, equivariant errors.

Even though significant effects were not found on most of the instructional days, the computer study guide treatment mean was the highest on every instructional day (see Table 3). The ordering for the educational group means was always LD, remedial, and regular education. Even though the means were not significantly different from one another, there is evidence that the computer study guide treatment was as effective as the lecture condition. For this sample of students (LD, remedial, and regular education), the computer study guide treatment resulted in higher daily quiz scores.

Significant treatment effects were found only on day 1. In two cases, there was not a significant difference between the treatment means: (a) among the students with learning disabilities there was no significant difference between the lecture and the lecture/computer study guide treatments, and (b) among the regular education students there was no significant difference between the lecture and the lecture/computer study guide treatments (see Table 4). When all students were combined there were significant differences among all three treatment group

pairings (i.e., lecture vs. computer study guide, lecture vs. lecture/computer study guide, computer study guide vs. lecture/computer study guide).

The most significant educational group effect also occurred on day 1. The only difference between two means that was not significant was the difference between regular education students and remedial students within the group receiving the computer study guide treatment (see Table 4).

On day 5 there was also a significant educational group effect. The Newman-Keuls test, applied to the data for day 5, found two instances in which the differences between educational group means were not significant (see Table 4). The first was for students receiving the lecture treatment. Remedial students did not do significantly better than the students with learning disabilities. Second, for students receiving the computer study guide treatment, the regular education students did not perform significantly better than the remedial students. When all students were combined there were significant differences within the three educational group pairings (LD vs. remedial, remedial vs. regular education, LD vs. regular education).

A significant educational group effect was also found on day 8 (see Table 4). On day 8, there were three cases in which no significant differences between educational group means were detected: (a) for students receiving lecture instruction, the remedial students did not score significantly higher than the students with learning disabilities, (b) among the students receiving lecture/computer study guide instruction, the regular education students did not score significantly better than the remedial students, and (c) for students receiving computer study guide instruction, the regular education students did not score

significantly better than the remedial students. When all students were combined there were significant differences within the three educational group pairings (LD vs. remedial, remedial vs. regular education, LD vs. regular education).

When there was a significant educational group effect -- days 1, 5, and 8 -- the regular education students always scored significantly better than students with learning disabilities. Remedial students generally scored significantly higher than students with learning disabilities, and regular education students for the most part scored significantly higher than remedial students.

The results for the posttest and retention test ANOVAs revealed significant educational group effects. The Newman-Keuls test was used to determine which pairs of means had significant differences (LD vs. remedial, remedial vs. regular education, LD vs. regular education).

Three differences on the posttest between educational group means were found not to be significant: (a) for lecture students there was no significant difference between the performance of students with learning disabilities and remedial students, (b) for students receiving the lecture/computer study guide instruction, the scores for the regular education students were not significantly higher than the scores for the remedial students, and (c) for students receiving the computer study guide instruction, the regular education students did not score significantly higher than the remedial students (see Table 2). When all the students were combined there were significant differences within the three educational group pairings (LD vs. remedial, remedial vs. regular education, LD vs. regular education).

Results of the Newman-Kuels for the retention test data found no significant difference between educational group means in three cases: (a) among those receiving lecture instruction there was no significant difference between remedial students and students with learning disabilities, (b) for students receiving lecture/computer study guide instruction there was no significant difference between remedial students and students with learning disabilities, and (c) for students receiving lecture/computer study guide instruction there was no significant difference between regular education and remedial students (see Table 2). When all the students were combined there were significant differences within the three educational group pairings (LD vs. remedial, remedial vs. regular education, LD vs. regular education).

The posttest and retention results are similar to the daily quiz results in that the regular education students always obtained significantly higher posttest and retention scores than the students with learning disabilities. The differences between the remedial versus regular education and LD versus remedial pairs were not always significant. Although no significant treatment effect was found for the posttest and retention test, students in the computer study guide treatment had a higher overall mean than students receiving lecture instruction or lecture/computer study guide instruction on both tests (see Table 5).

Reliability of Teacher Lecture Presentation

In order to ensure that all students were receiving equitable instruction, reliability observations were conducted during each of the teacher's 10 lectures. A checklist containing the topics to be included in each lecture was used. Lecture reliability was calculated by summing the number of topics covered in a lecture and

dividing by the total number of possible topics in a lecture. The average for the 10 day period was .91.

Study 2

Study 2 explored the use of hypertext computer assisted study guides as a follow up to teacher presented instruction in a small group A-B-A design. This study was conducted to ascertain if the computer study guides could be used as a means of instruction to bring lower-achieving students closer to a passing grade. A score of 50% was defined by the teacher as the passing grade in Washington State History. The students participated in an instructional unit made up of 10 hypertext study guide lessons three weeks after the conclusion of Study 1.

Method

Setting and Students

This study was conducted in the Macintosh computer lab adjacent to the social studies classroom. The five students who had the lowest Unit Test scores at the end of Study 1 participated in Study 2 (see Table 6). Two were students with learning disabilities and three students were remedial. Four of the students had been assigned to the lecture instruction group and one student had been assigned to the lecture/computer study guide group in Study 1. Socio-economic status, overall and specific achievement scores, and IQ information were not available from the school district. While specific reading levels for the students were unavailable, informal observation during the pilot test phase and Study 1 gave no indication that students had any serious difficulty in reading the materials presented to them.

Materials

Many of the materials from Study 1 were utilized again in Study 2. The same 10 hypertext computer study guides used in Study 1 were also used in Study 2. Student scores from the 50-item, multiple choice test which had been administered as the retention measure in Study 1 served as the pretest scores for Study 2.

The unit test was the pretest readministered to the students the day following the completion of the 10-day unit. The retention test was the unit test readministered to the students two weeks after the end of the unit. The daily quizzes were the same as those used in Study 1. The students had taken these quizzes in Study 1, but had received no feedback as to correct and incorrect answers. This factor along with the passage of time and the students' low scores in Study 1 made it feasible to use the same quizzes in Study 2.

Design and Procedures

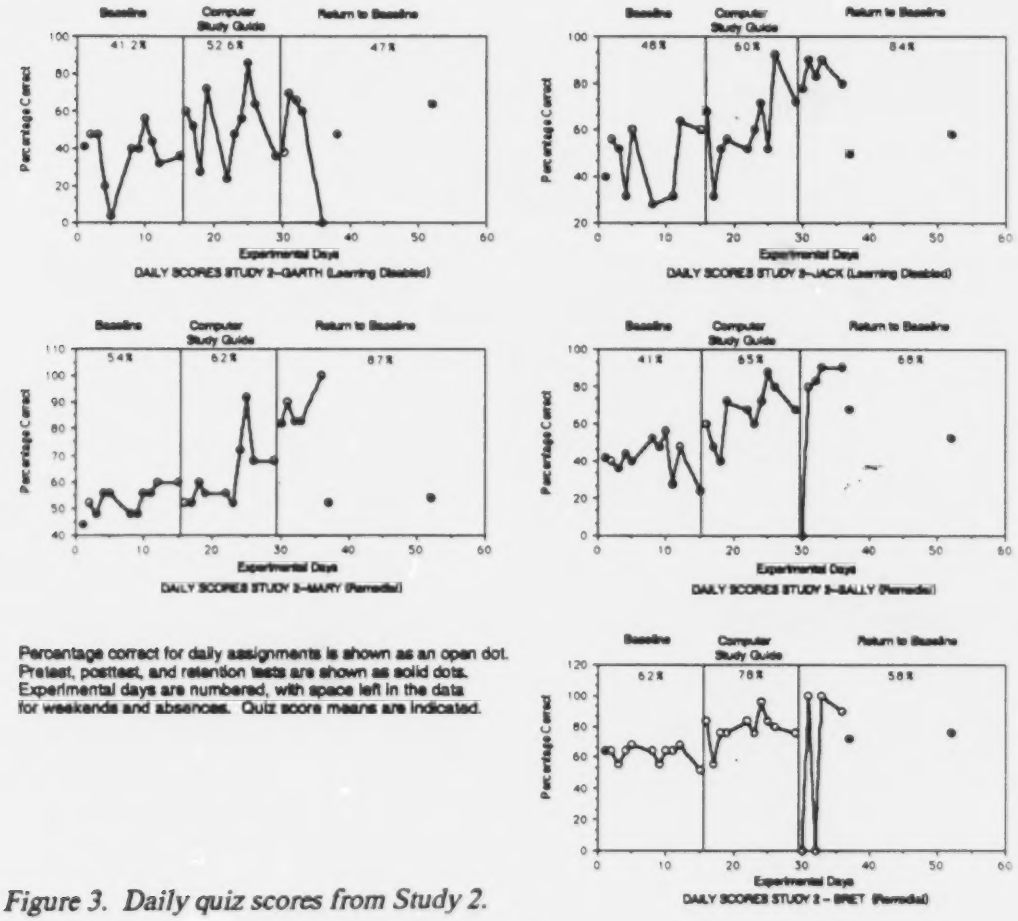
The baseline for Study 2 consisted of the 10 daily quiz scores from Study 1. The intervention was made up of the 10 computer study guide lessons. Return to baseline included the students' next five class grades immediately following the intervention. Data in the intervention phase contained the 10 daily scores from the multiple choice quizzes. The grades included in the return to baseline condition were daily class grades from worksheets and maps the students completed in class. Scores were converted to percentages and then plotted.

During the daily computer study guide lessons the students worked on the hypertext study guide for 30 minutes. They were then given the 25-item multiple

choice quiz and allowed up to 10 minutes to complete it. The quizzes were scored and the results graphed.

Results

The students' 10 quiz scores from Study 1 served as the baseline for Study 2. Data on student performance using the computerized study guides are shown in Figure 3.



Percentage correct for daily assignments is shown as an open dot. Pretest, posttest, and retention tests are shown as solid dots. Experimental days are numbered, with space left in the data for weekends and absences. Quiz score means are indicated.

Figure 3. Daily quiz scores from Study 2.

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For Garth, a learning disabled student, the computer study guide increased performance over baseline performance even though the scores were variable. The mean score increased from a baseline mean of 41% to an intervention mean of 52%.

In the intervention phase, quiz scores for Mary, a remedial student, remained low for the first six lessons. However, the last four data plots indicate rising scores. Even with the slow rise in quiz scores in this phase, the mean (62%) for these quizzes was higher than the baseline mean (54%).

The intervention phase quiz scores for Jack, a learning disabled student, continued the baseline variability but were generally higher. This is reflected in the increase from a baseline mean of 48% to an intervention mean of 60%.

Quiz scores for Sally, a remedial student, showed the largest gain while using the computer study guide. The baseline mean of 41% increased to 65% in the intervention phase.

Quiz scores for Bret, a remedial student, in the computer study guide phase are a continuation of his stable performance in baseline. The baseline mean of 62% increased to an intervention mean of 78%.

In the return to baseline phase, there was a decrease in daily scores for Garth and Bret. The return to baseline scores for Mary, Jack, and Sally reflect an increase in daily scores over the baseline and computer study guide phases.

Posttest scores for the five students showed an increase over the pretest scores. Posttest to retention test scores increased for all of the students except Sally. Sally's retention score reflected a decrease from the posttest, but remained above the 50% passing level established by the teacher.

Discussion

Computers and CAI have been used in education for many years. The enthusiasm and curiosity of educators concerning computers and CAI has not waned despite the transformations and revisions the technology has undergone throughout the years.

Study 1 and Study 2 were designed to explore the use of a specific computer concept, hypertext. Information presentation in the hypertext format, while not new to the computer world, is relatively new to education. Hypertext software has only recently become available to the microcomputer user. The use of the hypertext CAI study guides as a substitute for, or a supplement to, teacher presented instruction allowed for the exploration of the question: "If effective, how much and with whom?"

Study 1

The daily quiz scores indicate that although significant effects were not found on most of the instructional days, when the three educational groups were combined, students who worked with the computer study guides achieved higher quiz scores than students in the other two treatment groups for each of the 10 days. On six of the instructional days, the lecture/computer study guide students performed better than the lecture students; on four of the instructional days the lecture students had higher quiz scores than the lecture/computer study guide students. These findings suggest that the hypertext computer study guide, used alone or in conjunction with a lecture, is as effective as a well-prepared, teacher-delivered lecture.

Examination of daily quiz scores by educational grouping (learning disabled, remedial, and regular education) indicates that the computer study guide treatment was more effective for students with learning disabilities and remedial students, than with the regular education students. On seven of the instructional days students with learning disabilities who were in the computer study guide treatment scored higher on the quizzes than students with learning disabilities in the other two treatment groups. The lecture treatment was most effective on the remaining three days for the students with learning disabilities. The computer study guide treatment with the remedial students provided the highest quiz scores on eight of the 10 instructional days. The lecture/computer study guide treatment was most effective for the remedial students on the other two days. Although regular education students performed well on the quizzes compared to the other two educational groups, none of the three treatments provided them with a distinct advantage for higher quiz scores. The highest quiz scores for the regular education students were achieved with the (a) computer study guide on three days, (b) lecture on three days, and (c) lecture/computer study guide on three days. On one day scores for the lecture and the computer study guide treatments were the same for the regular education students.

The posttest results for the three educational groups combined (learning disabled, remedial, and regular education) indicate that the students in the computer study guide group had a higher overall test mean than the students in the lecture group or the lecture/computer study guide group. The lecture students' performance on the posttest was higher than the lecture/computer study guide students' scores. This finding is interesting in light of the retention test scores for

the combined educational groups. The lecture/computer study guide group had higher mean scores than the lecture group on the retention test. Again, the computer study guide group had the highest overall test mean on the retention test for the three treatment groups. The computer study guide perhaps afforded the students the level of interactive involvement necessary to retain information learned over time. The students in the computer study guide group achieved higher test scores on a comprehensive unit test and retained the information for a period of two weeks following the conclusion of the unit. The performance of the lecture group indicates that while the group achieved high scores on the posttest, the information was not retained over the two week period following the unit.

Examination of posttest scores by educational grouping (learning disabled, remedial, and regular education) shows that for the students with learning disabilities and regular education students, the lecture treatment produced higher scores than did the computer study guide treatment. The computer study guide treatment was more effective for the remedial students, however. Again these findings are interesting in light of the scores on the retention test. The retention test scores of the students with learning disabilities in the computer study guide treatment were consistent with their post test scores; whereas the retention test scores of the students with learning disabilities in the lecture treatment showed a marked decline from their posttest achievement. The retention test scores of the students with learning disabilities in the lecture/study guide treatment were higher than their posttest scores. This may indicate that the scores on the posttest of students with learning disabilities were not adequate measures of what the students had learned during the 10-day unit or that during the two week period following the

posttest the students were exposed to additional instruction that helped them on the retention test. The retention test scores of the remedial and regular education students in the lecture, lecture/study guide, and study guide treatments were fairly consistent with their posttest scores.

Conclusions

Several conclusions may be drawn from this study.

1. The hypertext computer study guide is as effective an instructional medium for students with learning disabilities, remedial students, and regular education students as a well-prepared lecture as measured by recall and retention of information both factual and inferential.

2. The hypertext computer study guide used in conjunction with a well-prepared lecture is as effective an instructional medium for students with learning disabilities, remedial students, and regular education students as a lecture alone as measured by recall and retention of information both factual and inferential.

3. The use of the hypertext computer study guide may provide some students the extra practice necessary to increase quiz performance.

4. Posttest scores are higher for students with learning disabilities, remedial students, and regular education students after having used the hypertext computer study guide.

5. Retention test scores are higher for students with learning disabilities, remedial students, and regular education students after having used the hypertext computer study guide.

Study Two

In Study 2, the 10 computer study guides were used as a follow-up to teacher presented instruction. The study was conducted to determine if the hypertext study guides could be used as a means of instruction to help lower-achieving students receive a passing grade.

Daily quiz scores of the five students during the intervention phase (computer study guides) were higher than during the baseline phase. Though there was some variability in the data, on most days during the intervention phase the daily quiz scores were above the 50% passing level established by the teacher.

In the return to baseline phase, there was a decrease in the daily scores for two students and an increase in scores for three students. This may be due to differences in the nature of assignments between the intervention and return to baseline phases. In the intervention phase the students completed daily quizzes; in the return to baseline phase the students worked on maps and worksheets with no teacher lecture. The three phases may have measured student performance in three different treatment conditions (lecture, computer study guide, independent work). It is also possible that five data plots are not enough to accurately measure the performance of this group of students, and that more data are needed to establish an overall trend in the return to baseline condition.

Scores on the posttests increased from the pretest for all five students. Four of the five students increased their posttest scores to above the 50% passing level; one student had a posttest score of 48%.

Posttest to retention test scores slightly increased for three of the students. This slight increase of scores from the posttest to retention for these students may

be explained by luck or guessing on the students' part as the scores indicate only a 2% to 8% increase. Two students' retention scores reflected a dramatic change from the posttest scores. One student's retention score reflected a 14% decrease from the posttest, but still remained above the 50% passing level. The second student's retention score reflected a 16% increase over his posttest score. It is felt that for this particular student the posttest as well as the daily quiz scores do not accurately reflect what the student had learned during the intervention phase. The variability of his scores throughout all phases in the study lends support to this conclusion.

Conclusions

Three conclusions can be drawn from this study.

1. Use of the hypertext computer study guide resulted in lower-achieving students receiving a passing grade on daily quizzes.

2. Use of the hypertext computer study guides resulted in score increases from pretest to posttest for lower-achieving students.

3. Use of the hypertext computer study guides resulted in little knowledge loss from posttest to retention test for lower-achieving students.

Summary

The results and conclusions from these two studies indicate that the use of hypertext to construct computer study guides holds promise for educators and researchers. The hypertext computer study guides were found to be as effective an instructional technique as a teacher presented lecture. This would indicate that the hypertext study guides could be used for students who (a) missed a lecture, (b)

need repeated exposure to all or part of the material covered in a lecture, and (c) need repeated exposure to lecture material in order to achieve a passing grade.

Use of the computer study guides by students with learning disabilities provided them with an increased ability to score a passing grade on daily quizzes. Particularly important for these students was the successful retention of information over time indicated by the similarity of their posttest and retention test scores.

Another advantage of the hypertext study guide for students with learning disabilities is that it allows for student control of and access to the material to be learned. This active involvement allows the student to move at an individual rate of speed as well as review material as many times as necessary. For high school students with learning disabilities the opportunity to have access to information more than once and have control over the presentation of that material may mean the difference between passing or not passing a course.

One of the clear advantages of the hypertext computer study guides for teachers is that they are easily incorporated into the existing classroom structure. No radical modification is necessary in the classroom or established teaching routine. The results of these studies indicate that the hypertext study guides can be incorporated as a substitute for teacher-led instruction, as a supplement to teacher-led instruction, and as added instruction for lower-achieving students. This allows a teacher to select the most advantageous use of the hypertext study guide for the lesson and student being taught.

Study guides, either traditional paper and pencil or computerized, are not often commercially available, however, and thereby have two distinct disadvantages (a) development time spent by the teacher to construct the new

learning materials is significant, and (b) the quality of the instructional design is limited to the ability of the teacher.

Research concerning the use of hypertext in education is just beginning. With little information existing about this new concept and its effect on student learning, there is a definite need for additional hypertext studies. Recommendations for further research in utilizing hypertext as an instructional tool for students with learning disabilities, remedial students, and regular education students include (a) a comprehensive description of subjects including socio-economic status, IQ, and achievement scores to provide more generalizable results, (b) intervention over a longer period of time to determine if the results are affected by familiarity or duration of use, and (c) item analysis of test questions (e.g., literal vs. inferential comprehension questions) to maximize use of the hypertext materials and provide information for improving them.

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Tables

Table 1: Description of Subjects by Treatment Group

	Lecture	Lecture / Computer Study Guide	Computer Study Guide
Numbers:			
male	9	9	11
female	5	2	4
total	14	11	15
Age:			
mean	14.6	14.6	14.6
Race:			
Anglo	12	10	14
Hispanic	1	0	1
Black	1	0	0
Asian	0	1	0
SES:	UN	UN	UN
IQ:	UN	UN	UN
Overall achievement:	UN	UN	UN
Specific achievement:	UN	UN	UN
Educational Group:			
LD	3	2	5
Remedial	6	4	5
Regular	5	5	5

Table 2: Comparison of Pre, Post, & Retention Test Averages

Educational Group	Pretest			Posttest			Retention		
	Lecture	Lecture / Computer Study Guide	Computer Study Guide	Lecture	Lecture / Computer Study Guide	Computer Study Guide	Lecture	Lecture / Computer Study Guide	Computer Study Guide
Students with Learning Disabilities	25 (18-40)	34 (26-42)	38 (0-48)	63 (46-74)	47 (22-72)	58 (54-62)	48 (40-64)	62 (42-82)	57 (44-68)
Remedial Students	41 (22-48)	39 (24-56)	38 (16-50)	58 (36-72)	67 (56-92)	72 (64-84)	57 (42-66)	70 (52-90)	70 (54-76)
Regular Education Students	47 (12-66)	51 (34-64)	47 (28-68)	82 (70-90)	76 (58-92)	80 (56-88)	79 (64-92)	76 (50-88)	81 (54-96)

Note. Scores expressed as percentage correct on 50 item test.
Range of test scores in ( ).

Table 3: Comparison of Daily Percent Averages

	Treatment Group			Educational Group		
	Lecture	Lecture / Computer Study Guide	Computer Study Guide	Students with Learning Disabilities	Remedial Students	Regular Education Students
Day 1	63 (0-100)	70 (48–100)	83 (48-96)	62 (44-88)	73 (40-96)	82 (0-100)
Day 2	66 (36-96)	71 (48-96)	76 (60-92)	62 (48-88)	70 (36-88)	80 (44-96)
Day 3	65 (32-92)	62 (20-88)	73 (48-100)	55 (20-84)	68 (40-92)	75 (48-100)
Day 4	70 (40-92)	61 (4-96)	73 (52-100)	53 (4-84)	71 (40-92)	80 (0-100)
Day 5	69 (28-96)	70 (40-96)	75 (52-92)	61 (28-88)	69 (48-92)	85 (60-96)
Day 6	75 (48-92)	72 (40-96)	76 (40-96)	66 (40-80)	71 (48-92)	87 (64-96)
Day 7	70 (56-80)	74 (56-92)	76 (56-96)	67 (56-76)	72 (56-92)	81 (56-96)
Day 8	71 (28-96)	81 (44-100)	86 (60-100)	66 (32-92)	80 (28-96)	91 (76-100)
Day 9	76 (48-92)	74 (32-88)	80 (56-96)	68 (32-88)	77 (48-92)	84 (56-96)
Day 10	74 (24-92)	75 (36-100)	80 (56-92)	68 (36-88)	78 (24-96)	84 (56-100)

Note. Scores expressed as percentage correct on 25 item test.
Range of test scores in ( ).

Table 4: Comparison of Daily Quiz Averages

Educational Group	Lecture	Lecture / Computer Study Guide	Computer Study Guide	Lecture	Lecture / Computer Study Guide	Computer Study Guide	Lecture	Lecture / Computer Study Guide	Computer Study Guide
	Quiz 1			**Quiz 5**			**Quiz 9**		
Students with Learning Disabilities	52 (44-56)	60 (48-72)	74 (48-88)	61 (28-88)	56 (40-72)	66 (52-80)	71 (64-76)	60 (32-88)	72 (60-88)
Remedial Students	61 (40-80)	69 (52-84)	87 (60-96)	63 (48-76)	68 (56-92)	76 (52-92)	68 (48-80)	81 (76-88)	83 (76-92)
Regular Education Students	76 (0-100)	80 (64-100)	89 (68-96)	83 (72-96)	87 (72-96)	83 (60-92)	89 (84-96)	80 (56-88)	84 (56-96)
	Quiz 2			**Quiz 6**			**Quiz 10**		
Students with Learning Disabilities	61 (52-72)	56 (48-64)	70 (60-88)	80 (0-80)	56 (40-72)	62 (40-76)	69 (60-76)	60 (36-84)	76 (64-80)
Remedial Students	57 (36-76)	78 (64-88)	76 (60-88)	61 (48-84)	71 (52-92)	79 (76-88)	65 (24-96)	84 (68-96)	83 (76-88)
Regular Education Students	79 (44-96)	78 (60-96)	82 (68-92)	85 (72-92)	90 (80-96)	87 (64-96)	88 (72-100)	82 (48-100)	80 (56-92)
	Quiz 3			**Quiz 7**					
Students with Learning Disabilities	60 (32-76)	44 (20-68)	62 (48-84)	70 (0-72)	66 (56-76)	64 (60-68)			
Remedial Students	55 (40-76)	70 (48-84)	78 (56-92)	62 (64-76)	73 (56-92)	80 (64-88)			
Regular Education Students	78 (56-92)	71 (56-84)	77 (48-100)	78 (72-84)	82 (68-92)	83 (56-96)			
	Quiz 4			**Quiz 8**					
Students with Learning Disabilities	72 (60-84)	28 (4-52)	58 (40-68)	56 (32-68)	68 (44-92)	74 (60-84)			
Remedial Students	61 (40-68)	71 (44-96)	81 (68-92)	65 (28-88)	85 (72-100)	90 (80-96)			
Regular Education Students	78 (76-92)	83 (0-96)	80 (52-100)	92 (88-96)	89 (76-100)	92 (84-100)			

Note. Scores expressed as percentage correct on 25 item test.
Range of test scores in ( ).

Table 5: Comparison of Pre, Post, & Retention Test Averages

	Treatment Group			Educational Group		
	Lecture	Lecture / Computer Study Guide	Computer Study Guide	Students with Learning Disabilities	Remedial Students	Regular Education Students
Pretest	38 (12-66)	42 (24-64)	41 (16-68)	33 (18-48)	40 (16-56)	49 (12-68)
Posttest	68 (36-90)	64 (22-92)	71 (54-88)	56 (22-74)	66 (36-92)	80 (56-92)
Retention Test	62 (40-92)	69 (42-90)	70 (44-96)	56 (40-82)	66 (42-90)	79 (56-96)

Note. Scores expressed as percentage correct on 50 item test.
Range of test scores in ( ).

Table 6: Description of A-B-A Subjects

Student	Gender	Age	Race	SES	IQ	Overall Achievement	Specific Achievement	Baseline Intervention Group	Educational Group
Garth	Male	14.9	Anglo	UN	UN	UN	UN	Lecture/Computer Study Guide	LD
Mary	Female	14.9	Anglo	UN	UN	UN	UN	Lecture	Remedial
Jack	Male	14.6	Hispanic	UN	UN	UN	UN	Lecture	LD
Sally	Female	14.6	Anglo	UN	UN	UN	UN	Lecture	Remedial
Bret	Male	14.6	Anglo	UN	UN	UN	UN	Lecture	Remedial